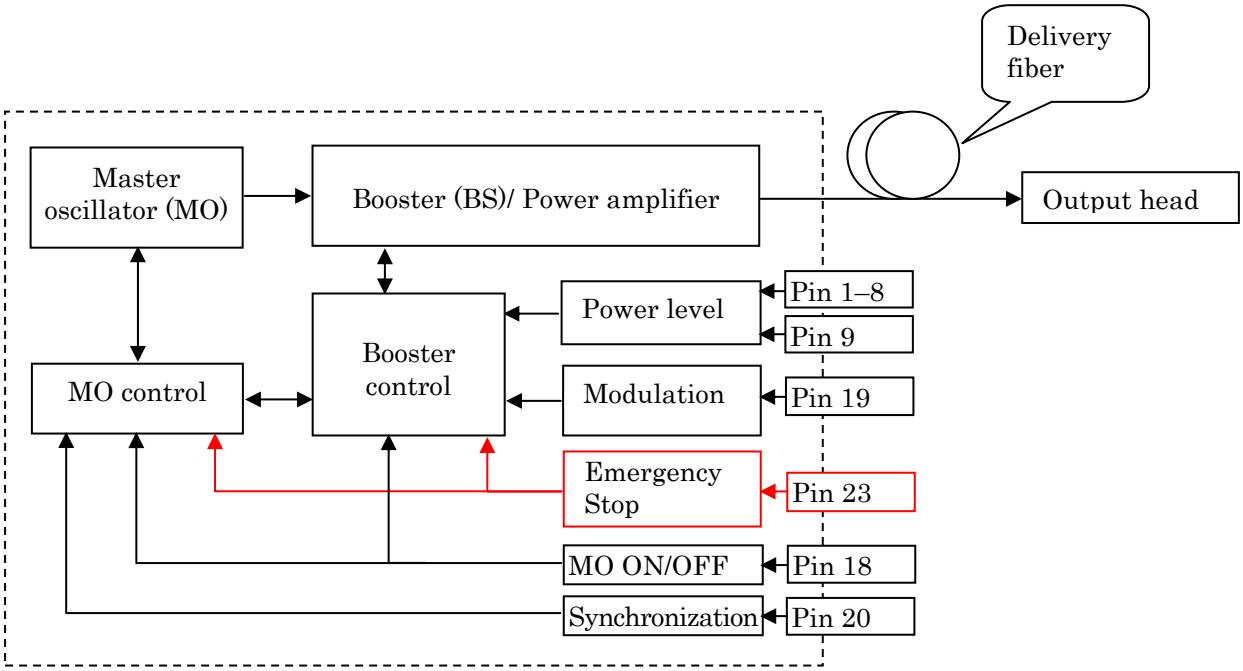
The document describes connection and control basics of YLP series pulsed lasers manufactured by IPG Laser GmbH and its sister companies.

Document applies to the lasers equipped with “type B”, “type B1” and “type B2”control interfaces.

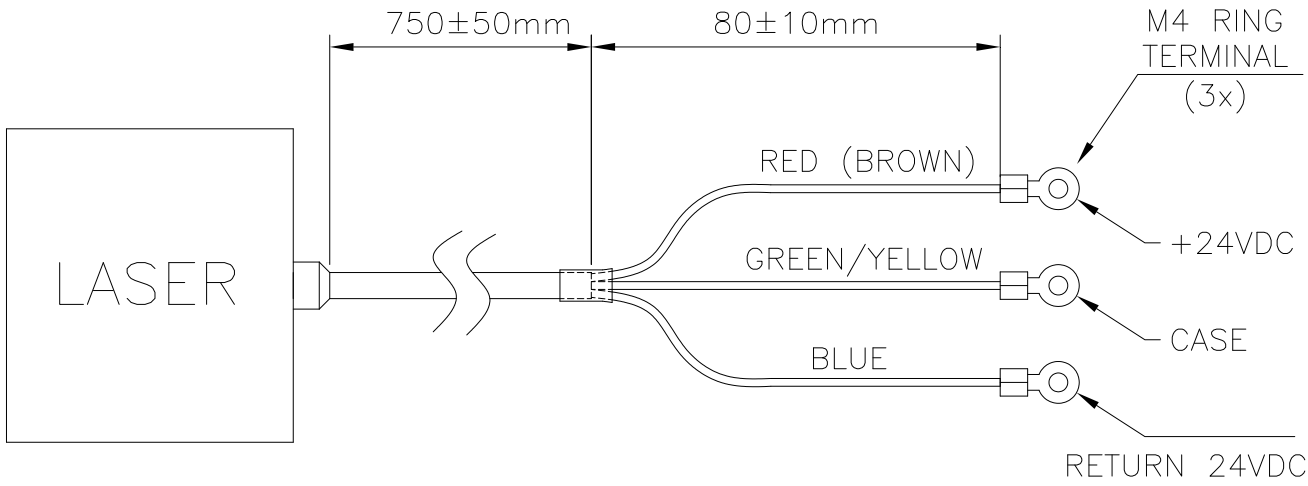
Contents:

Laser Internal Structure.

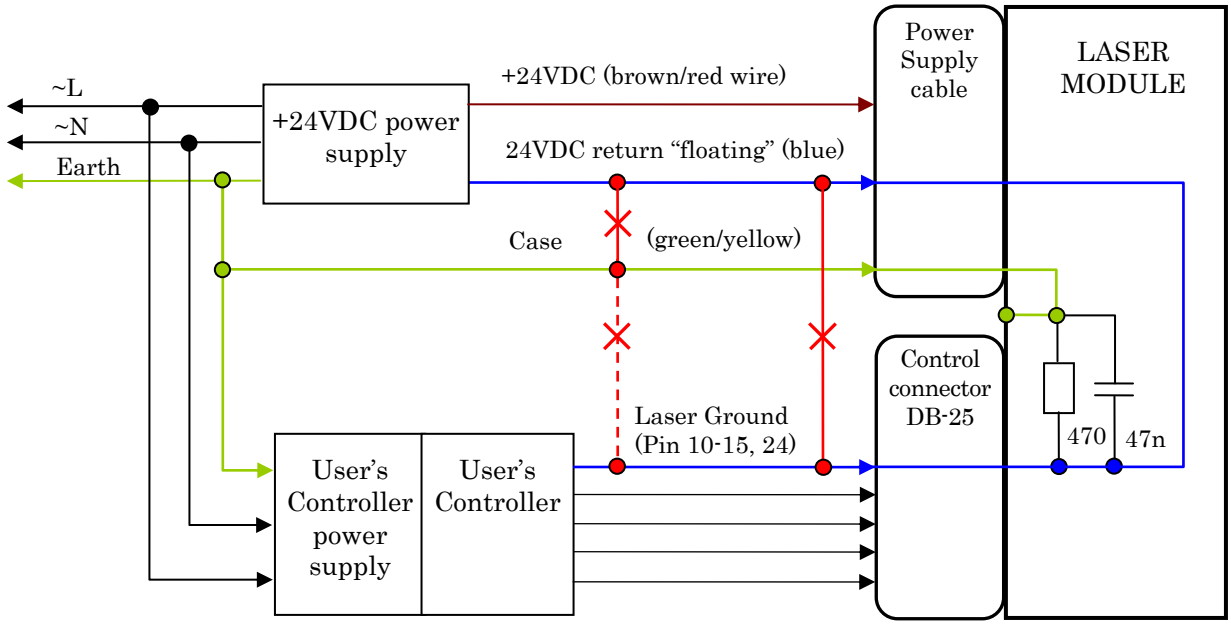


Electrical Connection

Laser power supply cable diagram is shown below.



Recommended laser connection diagram.



Following considerations should be taken into account for correct electrical connection:

1. Main power supply (24VDC) should be capable to permanently supply operating current (refer to the maximum current consumption in the laser specification) and supply 50% higher peak current for short periods up to 250us. Typical models of the laser consume less than 8A current, consequently peak current consumption for such models is less than 12A. Power supply should hold the voltage, measured on the laser cable leads, within a specified range (refer to the laser model specification) both for the steady and for the peak current consumptions. Supply voltage undershoots and overshoots out of the specified range may lead to a non stable laser operation. Power supply transient load regulation should be carefully investigated to choose a suitable power supply model.

2. Wires in the cable connecting main power supply and the laser supply cable should have proven length and cross section to ensure negligible voltage drop (especially for the peak current consumption).

3. The main 24VDC supply should have floating outputs. Its return wire should be connected only to the laser power supply cable (blue wire). Wrong connections, which may create current loops (shown in the diagram above as the crossed red wires) should be avoided.

4. Laser ground (DB-25 pins 10-15, 24) and laser supply 24VDC return (blue wire) are connected inside the laser module. No connections are allowed between these terminals outside of the laser module.

5. Inside the module common ground is connected to the laser housing via 470 Ohm resistor and parallel 47nF capacitor. This network equalizes potential between ground and the laser case.

6. Controller's card ground may be connected to the earth by design. If it is not, and the controller electronics has the floating ground, it should not be connected neither to the blue not to the yellow/green wires of the 24VDC laser supply cable (the crosses dashed red wire on the diagram).

Control Connector Pin Assignment, DB-25 plug.

All control pins are TTL compatible, unless otherwise noted in the pin description. For the interface designs level ranges of the TTL standard should be taken into consideration.

<table>
<tr><th>PIN No.</th><th>Description</th></tr>
<tr><td>1-8
(D0-D7)</td><td>Power Setting (0-FFh in hexadecimal or 0…255 in decimal formats).
LSB (D0) corresponds to Pin number 1, MSB (D7) corresponds to pin 8.
00h (0): Minimum output power
FFh (255): Maximum output power
Disconnected corresponds to 00h.</td></tr>
<tr><td>9</td><td>Latch. Latches power setting simultaneously with:
Type B, B1: rising edge
Type B2: falling edge.</td></tr>
<tr><td>10-15, 24</td><td>Ground</td></tr>
<tr><td>16, 21</td><td>Laser alarms status.
<table>
<tr><th>Pin 16</th><th>Pin 21</th><th>Status</th></tr>
<tr><td>LOW</td><td>LOW</td><td>Laser temperature is out of operating temperature range</td></tr>
<tr><td>LOW</td><td>HIGH</td><td>Normal operation</td></tr>
<tr><td>HIGH</td><td>LOW</td><td>Laser has automatically switched OFF due to high optical "Back Reflection" returned to the laser</td></tr>
<tr><td>HIGH</td><td>HIGH</td><td>MO failure</td></tr>
</table></td></tr>
<tr><td>17</td><td>Auxiliary 5±0.25VDC power supply input for independent operation of the guide laser (type B, B1) and PCB (type B2). Maximum current consumption:
Type B, B1: 0.15A
Type B2: 0.6A.</td></tr>
<tr><td>18</td><td>Master Oscillator (MO) ON/OFF signal.
HIGH: MO ON
LOW or disconnected: MO OFF</td></tr>
<tr><td>19</td><td>Laser Modulation input (Booster ON/OFF input).
HIGH: BS ON
LOW or disconnected: BS OFF</td></tr>
<tr><td>20</td><td>Pulse Repetition rate (Synchronization) input, square wave.
Refer to the specification for operating PRR range. Allowed duty cycle 0.1 to 0.9.</td></tr>
<tr><td>22</td><td>Guide Laser (red diode) ON/OFF input.
Type B HIGH or disconnected: ON
Type B LOW: OFF
Type B1, B2 HIGH: ON
Type B1, B2 LOW or disconnected OFF</td></tr>
<tr><td>23</td><td>Emergency Stop Input
HIGH: OK (Normal operation)
LOW or disconnected: STOP (Laser automatically switches OFF)</td></tr>
<tr><td>25</td><td>Optional laser output power monitor (average power).
Current loop 4-20mA, recommended load is 200 Ohm.
Calibration: 4mA=0W, 10mA=Nominal output power.</td></tr>
</table>

Control Interface Description.

1. The laser is controlled via signals applied to the DB-25 connector. Please refer to the connector interface description table above for pin designation and operating levels.

2. Pins 1 to 8 are the 8 bit bus for the output power setting. Pin 1 is the least significant bit and pin 8 is the most significant bit. Codes in the range 0…255 should be applied to these pins, which correspond to the power tunability 0…100% of the specified nominal value..

   Note: optical output power is not directly proportional to the settings.

3. Pin 9 is the "Latch" control wire to store power settings (pin1-8) into the laser. The data are stored in to the laser simultaneously with the rising (type B, B1) or falling (type B2) edge on the pin 9. Data on the pins 1-8 should be stable during the following time frames:

   Type B: 500ns before rising edge on pin 9
   Type B1: 1us before and 1us after rising edge on pin 9
   Type B2 20us after the falling edge on pin 9

   Stability of the data on the Pin 1-9 between out of above mentioned time frames is not required. IPG recommends supplying single positive pulse with duration longer than 2us to latch the data into the laser. Time interval between adjacent latching pulses should be longer than 100us (latching frequency less than 10 kHz).

4. Pin 16 and 21 are the alarm outputs. These pins indicate the following device states:

Pin 16	Pin 21	Alarm status
LOW	LOW	Laser temperature is out of operating temperature range*
LOW	HIGH	Normal operation
HIGH	LOW	Laser has automatically switched OFF** due to high optical "Back Reflection" returned to the laser
HIGH	HIGH	MO failure***

*In the case of temperature alarm for type B1 interface, MO and BS can not be switched ON until the error flag is reset.

**One second after "Back reflection" safety circuit activation, laser restarts (switches ON) automatically. The appropriate alarm status is cleared simultaneously with the restart.

***In the case of MO failure, MO and BS can not be switched ON until the error flag is reset.

To reset the flag:

Type B, B1: switch OFF and ON 24VDC main power supply

Type B2: set pin 18 to LOW

5. Pin 17 is an auxiliary +5VDC power supply voltage for the optional guide laser (red diode). The red laser can operate independently of the main +24VDC supply. This ensures safe laser CLASS 1 operation of the module, even in case of laser electronics malfunction.

   For type B2 interface this voltage also provides power to the PCB control electronics.

6. Pin 18 is the Master oscillator (MO) ON/ OFF signal. The MO should be switched ON at least 7ms before switching ON the Booster (BS). It can be switched OFF simultaneously with BS. After switching ON the MO, the laser starts to consume more electrical power and emits remnant power to the output even when BS pin19 is LOW. The average optical power of the operating MO passes through the BS without amplification and its average value is dependent on laser type (refer to the specification). For standard models it is less than 50mW after the output collimator.

   Note: the MO switches ON simultaneously with the rising edge on the pin. If the HIGH level was applied to the pin before supplying the main voltage (+24VDC) the laser does not recognize that as the MO ON state. The pin 18 should be dropped and set to HIGH level again after completing of warm-up phase in order to switch ON the MO. If the pin 19 was also in the HIGH state before supplying main +24VDC supply it should be also dropped to the LOW state simultaneously with pin 18.

7. Pin 19 is the "Emission modulation" of the Booster (BS) control input. Apply HIGH to switch ON the Booster and LOW to switch it OFF. The laser starts to emit optical power within specified delay after setting the pin to HIGH level and stops to emit with specified delay after setting to LOW level. Refer to the laser optical specification for the laser average power rise time and fall times. Modulation with period shorter than sum of the rise and fall times (the laser response time) may lead to the non adequate laser power behavior and significant optical over/undershoot. For the laser with less than 250us specified rise and fall times, the minimum modulation period should be longer that 500us.

   Note: the MO should be switched ON at least 7ms before switching ON the Booster. In case of switching ON BS while the MO is OFF, the laser does not start to emit. In case of switching ON the BS and later the MO, the laser starts to emit in range from 1 to 7 ms after switching ON the MO. The last two cases are not specified operating regimes and

should be avoided during handling with the laser. BS is switching ON simultaneously with rising edge on the pin. If the HIGH level was applied to the pin before supplying the main voltage (+24VDC), the laser does not recognize that as the BS switching ON signal. The pin should be dropped and set to HIGH level again using described switching ON procedure. If the pin 18 was also in the HIGH state before supplying main +24VDC supply it should be also dropped to the LOW while pin 19 stays LOW.

8. Pin 20 is the Synchronization input. Pulse repetition rate (PRR) within specified operating range should be applied to the pin (refer to the optical specification for PRR limits). The laser emits pulses simultaneously with the rising edge of the signal.

   Note: In case of supplying PRR out of the specified range (or missing the signal) the laser safety circuit will substitute missing pulses or limit the PRR.

9. Pin 22 is the guide laser control line. Apply HIGH to switch the guide laser ON and LOW to switch the guide laser OFF. If the guide laser option is not installed, pin 22 must be connected to ground (pin 10-15, 24) for interface type B since disconnected state corresponds to the guide laser being ON. For types B1 and B2 interfaces pin 22 may be either connected to ground or left floating.

   Note: the laser emission is not allowed simultaneously with the guide laser operation. BS is blocked internally during the guide laser operation. If the Emission Modulation (pin 19) was set to HIGH level during guide laser operation, the laser will not emit power, and will not start to emit even after switching OFF the guide laser. It is necessary to drop Emission Modulation pin and set it again to start laser emission. It is allowable to switch ON and OFF MO during guide laser operation.

10. Pin 23 is the "Emergency stop" input. It should be set to HIGH for normal operation. In case of dropping this pin to LOW state (even for a short period) the laser automatically switches OFF (similar state when both MO and BS are OFF) independently of other control signals. It is necessary to drop both MO and BS pins (if they were in HIGH state) to restart laser operation. For laser operation pin 23 should be set to HIGH at least 2us before supplying ON signals to MO and BS.

11. Pin 25 is the output power monitor. It is based on a 4-20mA current loop standard. Zero output power corresponds to 4mA current and nominal power corresponds to 10mA. Load of 200 Ohm is recommended. This output is optional and may not be installed in particular lasers models. It is not recommended for use in new developments.

Laser Operation.

1. Remove the protection cap from the laser output optical head and make the appropriate termination.
2. Connect the laser module to the control system via 25-pin connector. Use pins according to the description table.

   Note: Described laser interfaces are not compatible with the IPG "Remote control" drivers manufactured before year 2005.
3. Make sure that control pins are properly initialized.

   Namely:

   Pins 18, 19, 22 and 23 are LOW

   Pin 20 with repetition rate within specified range
4. Connect +24VDC power supply source to the laser and apply the voltage to the laser as described above.
5. In 5 seconds after supplying +24VDC power (warm-up time) the laser is ready for operation.

   Note: It is allowed to supply +24VDC main voltage first and later initialize control signals.
6. Set Emergency stop input (pin 23) to HIGH level.
7. Set desired power via pin 1-8. Apply the latch pulse to the pin 9 to store the power settings into the laser.
8. Switch the MO ON applying HIGH to the pin 18.
9. Wait 7ms.
10. Laser is ready for fast modulation via Pin 19. It is possible to apply HIGH and LOW sequence to switch the laser ON and OFF correspondingly. The laser has finite ON/OFF rise/ fall times (refer to the specification for the particular model). The speed of the modulation should not be faster than sum of rise and fall times. For typical specification of 250us rise/ fall times modulation period should be longer than 500us (corresponding frequency 2kHz).
11. After completing a sequence of laser ON/OFF switches and awaiting next one it is recommended to switch OFF the MO if the delay between sequences is more than 20ms. This will spare electrical consumption, avoid unnecessary wear of the MO and exclude remnant MO power at the laser output.
12. After finishing a job, switch OFF the BS and MO (set LOW to pin 18 and pin 19).
13. Remove +24VDC power supply voltage.

Operation Features.

1. PRR can be changed during laser operation by applying the appropriate signal to the pin 20. When varying PRR, be sure that longest duration between rising edges of the two adjacent pulses is not longer than the period of the lowest specified PRR. At the lowest specified PRR of 20 kHz this period is 50 microseconds. Otherwise, the safety circuit will detect missing pulses and will supply additional pulses to supplement the PRR signal. If the PRR is higher than maximum allowed PRR, the safety circuit will limit the PRR the maximum specified.
2. The power setting can be changed during laser operation by applying updated levels to pin 1-8 and latching them into the laser via pin 9. Laser response time to the power setting change is within specified delays for rise/fall times.
3. If pins 18 and 19 are in LOW state, there is no laser radiation at the operating wavelength.
4. If the MO is ON, and the BS is OFF, the remnant average power at the laser output is less that 50mW.
5. If the MO is ON and the BS is ON with zero power settings (all pins 1-8 were LOW during latching power into the laser) the remnant average power at the output is also less than 50mW.
6. The red diode can be switched ON during laser operation (if the option is installed) using pin 22. The guide laser should be turned ON only if the BS is OFF. If the BS is ON, the emission automatically stops. This should be avoided during operation. If it occurs, it is necessary to drop pin 19 to zero and set it back to HIGH level in order to switch BS again after finishing usage of guide laser.
7. The optional guide laser has own supply and control circuits. The guide laser may operate from either the +24VDC main supply or a separate +5VDC supplied to pin 17. If using a separate +5VDC, there is no electrical power supplied to the main laser circuits and the laser will not emit at any input control signals. If using +24VDC supply, there is no need to supply +5VDC to pin 17.
8. For types B interface make sure that pin 22 is connected to the ground (pin 10-15, 24) if the guide laser option is not installed. Disconnected state corresponds to the guide laser being ON..
9. Optional output power monitor accuracy is typically within ±30% of actual output power. This monitor cannot be used for reliable power measurement, use certified power meters to obtain correct output power values.

10. The laser automatically switches OFF, if the module temperature rises above +53°C. The appropriate alarm signal combination appears on the alarm pins 16 and 21. When the temperature drops down below +50°C the laser:

    Type B: automatically recovers the emission and the alarm pins combination is cleared;

    Type B1: does not recover the emission and holds the alarm pins unchanged until switching OFF main 24VDC power supply.

    Type B2: does not recover the emission automatically and holds the alarm pins unchanged. To switch ON the emission again switch OFF the BS and then switch ON back.

    For the devices with a remote Booster (power amplifier), this also relates to the remote head temperature.

11. The laser has an internal back reflection sensor. It switches emission OFF for approximately one second if the reflected level is dangerous for the laser. The appropriate alarm signals combination appears on the alarm pins 16 and 21. After one second the laser emission automatically recovers and the alarm pins combination is cleared.